



Self-recovery, Fatigue and Anti-fatigue of Supramolecular Elastomers

Drozdov, Aleksey D.; Christiansen, Jesper De C.

Published in:
Journal of Self-Assembly and Molecular Electronics (SAME)

DOI (link to publication from Publisher):
[10.13052/jsame2245-4551.2018016](https://doi.org/10.13052/jsame2245-4551.2018016)

Creative Commons License
CC BY-NC 4.0

Publication date:
2018

Document Version
Publisher's PDF, also known as Version of record

[Link to publication from Aalborg University](#)

Citation for published version (APA):
Drozdov, A. D., & Christiansen, J. D. C. (2018). Self-recovery, Fatigue and Anti-fatigue of Supramolecular Elastomers. *Journal of Self-Assembly and Molecular Electronics (SAME)*, 6(1), [16].
<https://doi.org/10.13052/jsame2245-4551.2018016>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal -

Take down policy

If you believe that this document breaches copyright please contact us at vbn@aub.aau.dk providing details, and we will remove access to the work immediately and investigate your claim.

Self-recovery, Fatigue and Anti-fatigue of Supramolecular Elastomers

A.D. Drozdov^{1} and J. deClaville Christiansen¹*

¹⁾ Aalborg University, Aalborg, Denmark

^{*)} E-mail aleksey@m-tech.aau.dk

Supramolecular elastomers (SMEs) are three-dimensional networks of polymer chains bridged by covalent cross-links and non-covalent bonds with finite lifetimes. The reversible non-covalent bonding is based on (i) metal-ligand coordination, (ii) electrostatic interaction, (iii) hydrophobic association, (iv) hydrogen bonding, and (v) host-guest recognition. An advantage of these materials compared with conventional vulcanized rubbers and thermoplastic elastomers is their ability of rapid self-healing after damage at ambient temperature. The mechanical response of SMEs is characterized by (i) rapid relaxation of stresses (with the characteristic time of a few minutes), (ii) self-recovery (a monotonic reduction in plastic strain with time after cyclic loading), and (iii) anti-fatigue (an increase in maximum stress with number of cycles under deformation programs with intervals of recovery between cycles).

A constitutive model is developed for the viscoelastic and viscoplastic behavior of supramolecular elastomers. Stress-strain relations are derived from the free energy imbalance inequality for an arbitrary three-dimensional deformation with finite strains. The viscoelastic response reflects breakage and reformation of temporary bonds in a transient polymer network (transition of chains from their active to dangling state and vice versa). The viscoplastic response reflects slippage of permanent junctions with respect to their reference positions. The model is applied to fit experimental data in tensile loading-unloading tests, relaxation tests, and multi-cycle tests on several SMEs. Numerical simulation shows that the governing equations describe adequately the experimental stress-strain diagrams, the material parameters evolve consistently with chemical composition of SMEs and experimental conditions, and predictions of the model are in agreement with observations.

Financial support by the Danish Innovation Fund (project 5152-00002B) is gratefully acknowledged.

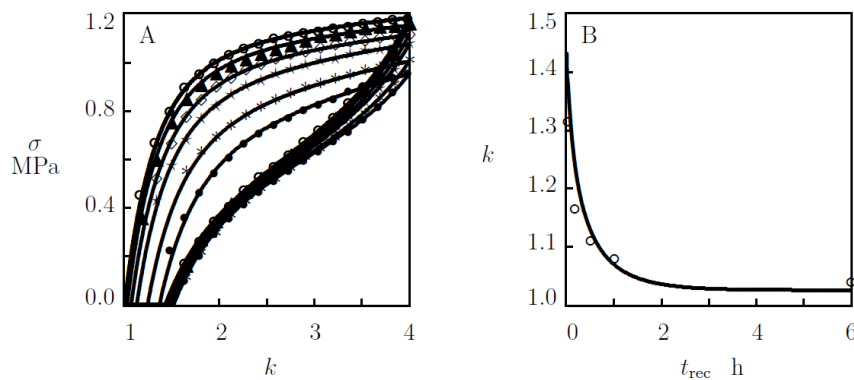


Figure 1. Self-recovery of PB-TAA elastomer. Symbols: experimental data. Solid lines: results of simulation.